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# A Logit Analysis of Participation in Tennessee's Forest Stewardship Program

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## *Abstract*

This study determines the likely effect of cost-share incentives on participation in the Tennessee Forest Stewardship Program and identifies other factors that may contribute to participation. A random utility model is used to determine the probability that a landowner will choose to participate in the program. A binary choice model is specified to represent the dichotomous decision and a logit procedure is used to fit the model. Data are obtained from mail surveys of 4,000 randomly selected landowners. Results indicate that attitudes and knowledge of forestry programs may be more influential in a landowner's decision to participate than monetary incentives.

**Key Words:** cost-share incentive, Stewardship Incentive Program, logit, nonindustrial private forest, NIPF, participation, forestry, trees

The vast majority of nonindustrial private forestland in Tennessee, and much of the nation, is currently in need of conservation treatment as evidenced in the National Resources Inventory (U.S. Department of Agriculture, Soil Conservation Service) and not producing to its potential (U.S. Department of Agriculture, Forest Service). This results in a reduction of the quality of timber and other forest resources such as wildlife habitat and water. In the 1990 Farm Bill, Congress instituted the Stewardship Incentive Program to "promote the principles of basic forest stewardship through nationwide planting, improvement, and maintenance of trees in order to increase reforestation, enhance the environment and aesthetic qualities of the United States's rural and urban areas and reduce global carbon dioxide levels." Some societal benefits from forest management are not perceived by landowners

(Skok and Gregersen). Therefore, incentives may be necessary to induce landowners to manage their forestland.

Historically, the federal government has concentrated its efforts on the use of monetary incentives to promote changes in existing farming practices. Consistent with past programs, cost sharing of start-up costs is a major incentive offered by the government in the Stewardship Incentive Program. However, participation in previous incentive-based forestry programs, such as the Forestry Incentives Program and the tree planting segment of the Conservation Reserve Program, has been chronically low in Tennessee even though, unlike the Stewardship Incentive Program, these programs enjoy the added incentive of an annual rental payment.

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The purpose of this study is to determine the likely effect of cost-share incentives on participation in the Tennessee Forest Stewardship Program, as well as to identify other factors that may contribute to participation. This information may prove useful in considering the most effective implementation strategy for the Stewardship Incentive Program in Tennessee. Although this study addresses a specific case, the methodology could be used to identify the effects of cost-share incentives and other factors on participation in Forest Stewardship Programs in other geographic locations.

A random utility model is used to determine the probability that a landowner will choose to participate in the Tennessee Forest Stewardship Program. A specified binary-choice model represents this dichotomous participate-not participate decision. Data obtained from mail surveys of 4,000 randomly selected Tennessee landowners and a logit procedure are used to fit the model. The estimated model is then used to evaluate the response of an individual having modal characteristics.

### Theoretical Model

For the indirect utility function we will follow the convention of a linear specification where the individual subscript is suppressed:

$$V_i = \beta_1 + \beta_2 Y + \beta_3 C + \beta_4 D + \beta_5 F + \beta_6 A + \varepsilon \quad (1)$$

where  $V_i$  is the indirect utility received by the individual from participating ( $i=1$ ) or not participating ( $i=0$ ) in the Stewardship Incentive Program;  $Y$  is current income from all sources;  $C$  is the cost associated with participating in the Stewardship Incentive Program such that  $C=va$ , where  $v$  represents the farmer's percentage share of the cost and  $a$  is the total establishment cost per acre;  $D$  is a vector of personal characteristics that influence participation including socioeconomic and demographic characteristics;  $F$  is a vector of farm features including size, current land use, and ownership type;  $A$  represents the attitudes and beliefs in conservation practices; and  $\beta_i$  are the parameters of the model with  $\beta_4$ ,  $\beta_5$ , and  $\beta_6$  each representing vectors of parameters.

Assuming a Gumbel distribution (Ben-Akiva and Lerman) with parameters ( $n=0$ ,  $u$ ), the probability that a landowner will choose to participate in the Stewardship Incentive Program is:

$$P_1 = \frac{e^{u^{v_1}}}{e^{u^{v_1}} + e^{u^{v_0}}} \quad (2)$$

Equation 2 is the binary logit model to be estimated where the individual subscript is suppressed for clarity.

### Data Collection

This study assumes that the Stewardship Incentive Program's initial target population will be those landowners who will yield the highest probability of success. Economies of scale make participation more difficult for small farmers (Dicks and Grano; Skok and Gregersen; and Rosson and Dolittle). Therefore, the survey concentrates on landowners with 100 or more acres.

According to an unpublished list from the Tennessee Division of Forestry there are approximately 17,622 nonindustrial private landowners with 100 acres or more. For this population size, approximately 400 questionnaires were required for analysis (Sanders).

A closed-ended, noniterative format was chosen to simplify the choice process. The "take-it-or-leave-it" approach is commonly used to estimate welfare functions and calculate welfare measures in a contingent-valuation framework (McConnell, Carson). This survey uses a similar design for those specific questions asking willingness to participate at given cost-shares. The method developed by Bishop and Heberlein, which is especially suited for mail surveys, was selected so the owner only had to make a judgment about a given cost-share. Hoen and Randall found that this method was compatible with the respondent's incentives since it would be in the respondent's best interest to answer "yes" if actual willingness-to-pay were greater than or equal to the amount asked, and to say "no" otherwise. A hypothetical situation based on the Stewardship Incentive Program is adopted because the actual program has not been in existence long enough to generate data on

participation. Furthermore, this approach accommodates presentation of cost-share incentives other than those offered by the current Stewardship Incentive Program in Tennessee.

In a single mailing, questionnaires were sent to 3,000 nonindustrial private landowners. A single cost share of either 50 percent, 65 percent (the Program's current incentive level) or 75 percent was presented to each landowner. One thousand surveys were sent at each cost-share amount. Recipients were asked if they would participate in the Stewardship Incentive Program at the cost-share presented to them. As part of a separate survey involving the effect of information on willingness to participate, another 1,000 questionnaires at the 65 percent cost-share level, which also included a summary of costs and revenue associated with timber production, were mailed to a separate group of randomly chosen landowners. Responses were combined after analysis of covariance indicated no significant difference due to the absence or presence of the additional information.

A total of 455 questionnaires from both surveys was returned for a response rate of 12 percent. However, 77 of these were disqualified as follows: 22 for not answering key questions, nine because the landowner reported a total of less than 100 acres, three because they were not nonindustrial private owners, and 43 submitted protest responses to the participation question, indicating that they would not participate under any circumstances because of government involvement. In summary, 378 questionnaires were used in the analysis for a final 9.5 percent response rate.

To check for bias, the sample means (or percentages where appropriate) for age, farm size, tenure, occupation, sex, ownership and acres of woodland/cropland/pasture were compared to the 1987 Census of Agriculture (U.S. Department of Commerce). The only characteristics that varied significantly were the average farm size and the acres of land use. This difference was explained by a single outlier that skewed the mean.

## Variable Definitions

### *Dependent Variable*

The dependent variable (*PART*) is evaluated as an unobserved utility measure determined by the observable choice of whether to participate in the Stewardship Incentive Program. A value of 1 was assigned for those respondents who said they would participate in the Stewardship Incentive Program at the cost share presented to them. A value of 0 was given for those who would be unwilling to participate.

### *Independent Variables*

The independent variables are summarized in table 1. Five dummy variables (*INCD2-6*) capture the income relationship (*Y*), with *INCD6* representing incomes greater than \$50,000 and *INCD1* representing incomes under \$10,000, the rest are in increments of \$10,000. Higher incomes are hypothesized to be associated with higher probabilities of participation.

The cost associated with participation (*COST*) includes a value for *v* which is the cost-share percentage presented to the individual and an assumed total establishment cost of \$80 per acre (Wells). Typical start-up costs for a Tennessee mixed hardwood forest provide the basis for the establishment cost since hardwood forests accommodate most of the Stewardship Incentive Program's goals. A negative relationship is hypothesized between *COST* and the probability of participation.

Personal characteristics (*D*) are represented by education and occupation. The Tennessee Forest Stewardship Program requires an understanding and knowledge of forest resource management and, if an individual does not already have the expertise, it must be learned. Individuals with a higher level of education will be more likely to have gained a broader expertise or may be more willing to learn what is necessary. The level of education is expected to have a positive relationship with participation. A dummy variable (*EDUC2*)

**Table 1. Summary of variables used in logit model to estimate participation in an incentive-based forestry program**

Variable Group	Stated Hypothesis	Expected Sign	Variable Name: Description	Frequency In Sample	
			<i>PART</i> : 1 = if willing to participate, 0 = otherwise	1 = 202	0 = 176
Y	the higher the income, the more likely the individual will be to participate	+	<i>INCD1-6</i> : six dummy variables; income level 1 is captured in the constant, the other levels are each dummy variables	1 = 31 2 = 43 3 = 54	4 = 41 5 = 58 6 = 51
C	the higher the cost borne by the farmer, the less likely he/she will be to participate	-	<i>COST</i> : single variable: farmer's share of cost times \$80/acre	75% 65% 50%	102 172 104
D	the higher the level of education, the more likely they will participate	+	<i>EDUC2</i> : single variable categorized in years of school completed: 1 1-6 years 2 6-8 years 3 8-12 years 4 high school graduate 5 some college 6 college graduate 7 advanced degree	1 = 3 2 = 22 3 = 25 4 = 66 5 = 77 6 = 92 7 = 93	
	individuals whose primary occupation is agriculture related will be more likely to participate	+	<i>OCCUP</i> : 1 = farmer/forestry 0 = all other occupations	1 = 94 0 = 284	
F	as the amount of acreage owned increases so will participation	+	<i>ACRE</i> : continuous variable of actual acreage owned		
	large farms will be more likely to participate than small	+	<i>SIZE</i> : 1 = ownerships of 10,000 or more acres 0 = all others	1 = 7 0 = 371	
	those with unmanaged forest and pasture as primary land use will be more willing to participate than others	+	dummy variable for land use classification: <i>CONSTANT</i> : managed forest land, <i>PSTR</i> : pasture, <i>UMGD</i> : unmanaged forest land, <i>CROP</i> : cropland, <i>OTHER</i> : all other uses	mgd unmgd ptr crop other	62 218 46 2 8
A	the stronger the desire for each goal as well as multiple goals the more willing to participate	-	<i>GOALS</i> : single variable: an index was developed from the survey such that the lower the number the stronger the desire for any goal	6 - 37 7 - 16 8 - 34 9 - 33 10 - 41 11 - 30 12 - 41 13 - 23 30 - 4	14 - 82 15 - 17 16 - 32 17 - 8 18 - 23 19 - 3 20 - 2 21 - 0 22 - 1 23 - 0 24 - 2 25 - 0 26 - 0 27 - 0 28 - 0 29 - 0
	the stronger the feeling for conservation, the more willing to participate	+	<i>CONEXP</i> : 1 = if any previous experience 0 = no prior experience with conservation practices	1 = 211 0 = 167	
	those with previous experience will be more likely to participate	+	<i>FEXP</i> : 1 = any prior experience with forestry 0 = no prior experience with forestry	1 = 318 0 = 60	

distinguishes between those individuals with at least some college education and those with a high school level or less.

The expectation is that an agriculture-related occupation increases the likelihood of participation as a result of familiarity with farm practices and production factors. Occupation is represented by a dummy variable (*OCCUP*) which differentiates agriculture-related jobs from all other occupations.

The vector of farm features (*F*) is represented by the number of acres owned (*ACRE*), a farm-size dummy variable (*SIZE*) to test the hypothesis that individuals who own 10,000 acres or more will participate differently than those with smaller farms, and a set of dummy variables representing the individual's current primary land use category. The *ACRE* variable, which determines the slope, and the *SIZE* dummy variable, which adjusts the intercept for large farms, are expected to be positively related to participation in the Tennessee's Forest Stewardship Program because of economies of scale and greater ability to invest over the long term. Current primary land use represents the owner's largest land-use category in terms of acres from among managed forestland (intercept), unmanaged forestland (*UNMGD*), pasture (*PSTR*), cropland (*CROP*), and all other land uses (*OTHER*). Those with unmanaged forestland or pasture as their primary land use are expected to be more willing to participate than the others.

Five variables are used to evaluate the vector of attitudes and beliefs in conservation practices (*A*). The first variable (*GOALS*), which ranges from 6 to 30, represents the individual's opinions about the six goals of the Stewardship Incentive Program, with 6 indicating strong support for all goals and 30 indicating strong opposition to all goals. As structured, *GOALS* is a negative-attitude index. It is expected to be negatively related to participation.

Previous or current experience with forest management (*FEXP*) reflects a positive attitude toward the program and is expected to positively affect participation. As with experience in forest management, previous experience with conservation or other resource management programs (*CONEXP*)

is assumed to reflect a positive attitude toward the goals of the program and is expected to have a positive influence on participation.

Previous work has shown that knowledge depicts interest in a program and will increase participation. Esseks and Kraft (1988) found, in two of their four sites, that recipients of technical assistance from government agencies or individuals enrolled in a government program in the last two years had a significantly higher probability of bidding in the Conservation Reserve Program. A later study by Esseks and Kraft (1989) determined that visits to government offices, especially the Agriculture Stabilization & Conservation Service, made a significant difference in an individual's knowledge of a program. As with Esseks and Kraft, this study expects the desire for information (*INFOS*) and the receipt of information (*INFOR*) to be positively related to participation.

### Parameter Estimates

The model was estimated using a binary logit model (Ben-Akiva and Lerman, Judge et.al.). Table 2 includes the maximum likelihood estimated coefficients, t-ratios, weighted-aggregate elasticities, changes in probability, likelihood-ratio test, McFadden R-Square, and prediction success statistics. Measures of the goodness of fit indicate that the model fits the data fairly well. The likelihood-ratio test, which measures the significance of the logit function, was highly significant with a score of 84.3, suggesting that there is a relationship between the probability of an individual choosing to participate and the suggested variables. McFadden's R-Square is 0.16, slightly under the 0.20 and 0.40 range which Hensher and Johnson consider would connote "extremely good fits." The model correctly predicted 68 percent (257 out of 378) of the responses. Correct predictions were relatively evenly distributed with 59 percent of the nonparticipants (104 predicted, 176 actual) and 76 percent of the participants (153 predicted, 202 actual) correctly predicted.

Interpretation of the estimated coefficients must be done with caution since the parameter estimates are the weights of that parameter which, when multiplied by the left side of the equation, will effect that much change in the probability

**Table 2.** Parameter estimates and statistical relationships of the logit model used to estimate participation in an incentive-based forestry program

Variable Name	Estimated Coefficient	T-Ratio	Weighted Aggregate Elasticity	Change In Probability
<i>COST*</i>	-0.03000	-1.87750	-0.32408	-0.00590
<i>EDUC2</i>	0.03261	0.34582	0.06352	0.00647
<i>OCCUP</i>	0.08587	0.29492	0.00815	0.01702
<i>FEXP*</i>	0.86755	2.50760	0.27351	0.17199
<i>ACRE</i>	-0.00009	-1.38930	-0.03733	-0.00002
<i>SIZE</i>	2.57730	1.16140	0.01369	0.51094
<i>UNMGD*</i>	0.93900	3.09460	0.20175	0.18615
<i>PSTR*</i>	1.12000	2.55070	0.04712	0.22204
<i>CROP*</i>	1.28770	2.29660	0.02898	0.25528
<i>OTHER</i>	0.27444	0.32342	0.00215	0.05441
<i>GOALS*</i>	-0.13010	-4.19330	-0.56929	-0.02580
<i>CONEXP</i>	0.24665	0.97318	0.05298	0.04890
<i>INFOR</i>	0.13675	0.41493	0.04134	0.02711
<i>INFOS*</i>	1.94980	3.06980	0.69290	0.38654
<i>INCD2</i>	0.02163	0.03814	0.00092	0.00429
<i>INCD3</i>	0.49658	0.90291	0.02740	0.09844
<i>INCD4</i>	0.24220	0.41940	0.01036	0.04802
<i>INCD5</i>	0.36181	0.66468	0.02260	0.07173
<i>INCD6*</i>	1.04170	1.99540	0.14847	0.20651
Constant	-1.70520	-1.55600	-0.63258	-0.33805
Log-Likelihood Ratio Test				84.3
McFadden R <sup>2</sup>				0.16
Prediction Success:			Concordant	68
			Discordant	32

\* denotes significant at  $\alpha < 0.1$

(Pindyck and Rubinfeld; Neter, et. al.). Using Pindyck and Rubinfeld's recommendation, the estimated results were interpreted by solving for the change in probability ( $\Delta P_i$ ) at the mean:

$$\frac{\sum \Delta P_i}{n} = \frac{\sum \beta [P_i(1 - P_i)]}{n}$$

(3)

where  $P_i$  is the estimated probability of participation at each observation;  $\beta$  is the estimated coefficient for a parameter; and  $n$  is the number of observations.

The change in probability is a function of the probability itself and when multiplied by 100 is

the percentage change in the probability of the event occurring given a change in the variable, ceteris paribus. For example, a 1 unit increase in *GOALS* will result in a 2.6 percent decrease in the probability of participation (Pindyck and Rubinfeld, Jarvis).

Another generally accepted method of interpreting the estimated coefficients is the weighted-aggregate elasticity, also known as the sample enumeration method (Hensher and Johnson). The elasticity for each individual is estimated at the mean and then aggregated, weighting each individual elasticity by the individual's estimated probability of choice. The weighted-aggregate

elasticity indicates that a 1 percent change in the independent variable will result in a corresponding percentage change in the overall probability of participation holding everything else constant (Hensher and Johnson). For example, a 1 percent increase in *GOALS* would result in a 0.57 percent decrease in the probability of participating in the Stewardship Incentive Program. Obviously, this interpretation is not easily understood in the case of dummy variables, since it is not clear what a percentage change in a dummy variable represents.

Examination of the income coefficients reveals that only *INCD6* (incomes greater than or equal to \$50,000) is significant. This means the probability of participation will not be different for individuals with incomes under \$50,000, however, for incomes greater than or equal to \$50,000 a shift occurs and the probability of participation increases. The change in probability suggests that a landowner in this high-income category would be 20.7 percent more likely to participate than individuals in other income categories.

The variable *COST* has a significant coefficient with a negative sign as expected, connoting the higher the cost borne by the farmer, the lower the probability of participation in the program. The change in probability indicates that an increase in the cost share offered from 50 to 75 percent would increase the probability of participation by a total of about 15 percent [(75-50) • -0.0059].

The *OCCUP* and *EDUC2* variables (*D*) are both nonsignificant but do have the expected signs. Although research of similar programs found these variables to be significant, the reported research dealt mainly with crop-related programs. The nature of growing a forest is quite different in that it is a long-term investment requiring inputs of land but limited labor, such that owners with occupations other than farming may find forestry an acceptable land-use option. Farmers, on the other hand, may not be able to convert crops to forest and may only be willing to enroll existing unmanaged forests or unused pasture.

Attributes of the farm (*F*) are significant only for *UNMGD*, *PSTR* and *CROP*. The coefficients of these dummy variables indicate that

landowners with these primary land uses are more likely to participate than landowners with managed forestland and "other" land uses as their primary land uses. The changes in probability for these variables indicate that owners with cropland as the major land use have the highest probability of participating and are 25.5 percent more likely to participate than those with managed forestland as the primary use. The other land use variables are similarly interpreted.

Variables estimating owner attitudes and opinions have the highest significance in the model. The model suggests that a positive relationship exists between willingness to participate and the respondent's feeling for the goals of the Program. The range for *GOALS* is ranked such that a 6 signifies a strongly supportive respondent, while a 30 represents one who strongly opposes all goals. The change in probability indicates that a one unit change toward a more favorable attitude, for example, from 15 to 14 total points, increases the probability of participating by 2.6 percent. With this in mind, a landowner who strongly supports the Program's goals is 61.9 percent [(30-6) • -0.0258] more likely to participate in the Tennessee's Forest Stewardship Program than one who strongly opposes its goals.

The *FEXP* variable is also highly significant and exhibits a strong positive relationship with participation. The change in probability reveals that landowners who have any type of experience with forestry programs are 17.2 percent more likely to participate. However, *CONEXP* is not significant, suggesting that conservation program experience has little effect on participation in the Stewardship Incentive Program.

Landowners who seek out information about land-use practices or programs are 38.7 percent more likely to participate than those who do not, as indicated by the highly significant coefficient for *INFOS* and its corresponding change in probability. On the other hand, the nonsignificant coefficient for *INFOR* indicates that receiving information from various government agencies does not influence participation. Apparently, the effort used by individuals to gain knowledge regarding farming or forestry practices is a reflection of their



interest or attitude and is a good indicator of potential participation.

Taking all variables together, the individual most likely to participate would have a family income of \$50,000 or greater, experience with forestry, actively seek information regarding land-use practices and programs, support conservation and the goals of the Forest Stewardship Program, and have unmanaged forest, pasture or cropland as primary land uses.

### **Analysis**

The results of this model suggest that a negative attitude regarding the goals of the program could outweigh the program's benefits to the landowner including monetary gains, such that the individual will not participate regardless of the cost share offered in this survey. Figure 1 demonstrates the effect of varying cost shares and attitudes toward the goals of the program on a typical (modal) respondent's probability of participating, given the set of variables defined in table 1.

A negative attitude index greater than 23 results in a less than 50 percent probability of participating at any cost share between 50 and 75 percent. Individuals with attitude indexes less than 20 have a greater than 50 percent probability of participating at any cost share. This is very significant for policy decisions aimed at an implementation strategy. The model suggests that cost-share incentives may be wasted on typical landowners who have strong positive attitudes. For these individuals, the incentive only acts as a substitute for autonomous investment. On the other hand, cost-share incentives are not likely to influence landowners with strong negative attitudes.

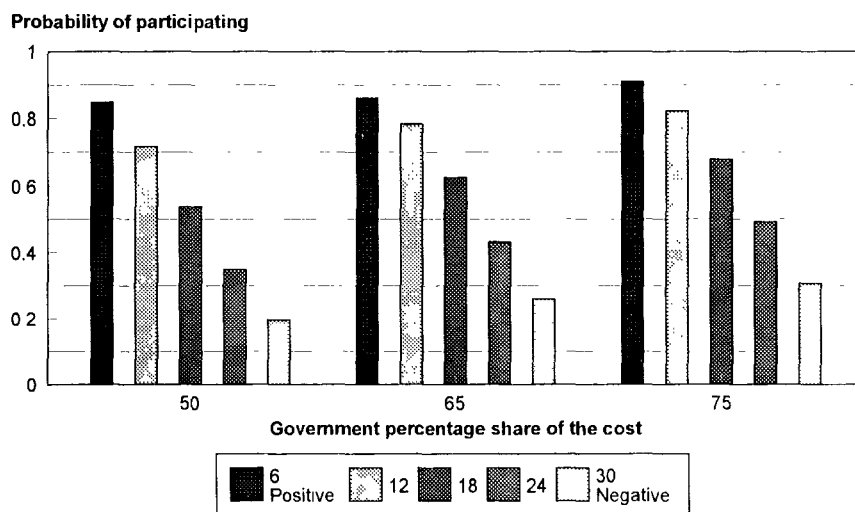
Traditionally, direct financial incentives have been used as the primary tool to increase willingness to participate. However, it is important to realize that individuals with an attitude of 23 or greater are unlikely to participate at any of the offered cost-share incentives and only a change in attitude will promote participation. This model indicates that activities aimed at creating a more

favorable attitude toward the goals of the program may have a stronger influence on participation than monetary incentives. The most effective approach may be to identify landowners who have previously sought out information on forestry and conservation practices and/or who have previous forestry experience. These individuals may be easily identified from participation records or from records of individuals who inquire about programs. The results also suggest that an effective approach might be to concentrate on improving attitudes through environmental education and indirect incentives such as training and technical assistance. According to the estimated model, experience with forestry would have a substantial impact on willingness to participate. Along with increasing the individual's willingness to participate, experience through training programs would also promote progressive forestry practices and increase the quality of forest resources.

### **Summary and Conclusion**

The results suggest that both direct and indirect incentives may be useful in promoting participation in Tennessee's Forest Stewardship Program. To maximize participation, implementation should concentrate time and resources on those activities that improve attitudes, and increase knowledge and experience rather than increasing the cost-share incentive. However, since the Stewardship Incentive Program is constrained by a budget, the problem becomes one of allocating that budget to achieve maximum participation. To address this problem, the cost of increasing participation by changing attitudes must be compared with the cost of offering a higher share of the start-up cost. The identification of such costs is vital to making sound policy decisions regarding the most efficient way to promote the Tennessee Stewardship Program.

Low participation rates in forestry programs may be a problem for states other than Tennessee. The methodology used in this study, however, would certainly be appropriate for identifying strategies for increasing participation in Forest Stewardship Programs in those states.

**Figure 1.** Effect of changes in attitude and cost share on the modal respondent

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